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ABSTRACT

A computer-based questionnaire was developed to help parents who have not received specialized training to determine whether their young children need further assessment for diagnosis of developmentally at-risk status. The computer automatically determines a starting point for a series of questions according to the child's chronological age. The computer also sets the basal point according to the child's functional level. When the child reaches a certain ceiling point, the computer stops asking questions, calculates the total numbers of "yes" and "no" answers given by the respondent, and presents a graphical representation of the child's development. The questionnaire items are written in simple language and use pictures where possible. The validity of the instrument was examined to see how precisely the parent-completed questionnaire assesses children's development as compared to the Child Developmental Inventory, a standardized assessment tool. Results suggest that the parent-completed computer-based questionnaire is a valid tool in screening 15-month-to 36-month-old children's development. (Contains 32 references and 3 tables.) (Author/AEF)

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Research Paper: Curriculum and Instructional Strategies

Parent-Completed Screening Test for Developmentally At-Risk Young Children

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Abstract

A computer-based questionnaire was developed to help parents who have not received specialized training to determine whether their young children need further assessment for diagnosis of developmentally at-risk status.

The computer will automatically determine a starting point for a series of questions according to the child's chronological age. The computer will also set the basal point according to the child's functional level. When the child reaches a certain ceiling point, the computer will stop asking questions and will calculate the total numbers of "yes" and "no" answers given by the respondent and will present a graphical representation of the child's development. The questionnaire items are written in simple language and use pictures where possible.

The validity of the questionnaire was examined to see how precisely the parent-completed computer-based questionnaire assesses children's development as compared to the Child Development Inventory, a standardized assessment tool. Correlations among the five domains of the computer-based questionnaire and the corresponding domains of the Child Developmental Inventory were significant and strong (from $r = .61$ to $r = .86$, $p < .001$). The sensitivity of the computer-based questionnaire, as indicated by the percentage of developmentally at-risk children correctly identified according to the Child Developmental Inventory, was 80%. The specificity of the computer-based questionnaire, as indicated by the percentage of children without problems correctly identified according to the Child Developmental Inventory, was 100%. The computer-based questionnaire had brief administration

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time with a mean of 8.8 minutes. These results suggest that the parent-completed, computer-based questionnaire is a valid tool in screening 15-month- to 36-month-old children's development.

For many years, professionals have assessed children with disabilities and determined goals for them based solely on their own observations (Garshelis & McConnell, 1993). Parents have a rich history of observations and experiences with their children, and information obtained from parents represents a highly desirable source of input that can contribute unique and essential information to the assessment process (Henderson & Meisels, 1994). However, the utilization of parental information in assessment of young children has generally been overlooked. A major reason that parents have been excluded from assessment is the belief that assessments must be administered in a typical fashion and only by a person having required training. Even when assessment tools are based on naturalistic observation, parental involvement has been limited because of the belief that observational skills are also obtained with extensive training (Sheenhan, 1988). Compliance with P.L. 99-457, with such a large population, is difficult for at least two reasons: 1) a limited number of professionals; and 2) financial cost of screening. Utilizing parents to screen their children's development seems reasonable from an economic perspective and has parents as partners at the starting point of the intervention journey. However, these two advantages are of little use unless parents can reliably assess the child's performance.

In order to help parents conduct assessment procedures in a standard way, computer technology can be employed, especially for the assessment of exceptional children (Greenwood & Rieth, 1994; Pea, 1987). Several advantages can be assumed when using the computer in assessment measurement. The computer can: (a) reduce the total assessment administration time; (b) give immediate feedback to responses; (c) reduce recording and computing errors, and increase scoring reliability; (d) improve responder's motivation; and (e) provide a standard procedure of the test administration that can help to get information from parents reliably.

Though recent advances in technology make it possible to improve the assessment procedure, only a few studies have examined the implication of computer-based assessment in special education. Further research is in order to examine whether parents can successfully complete computer-based screening questionnaires on their children. The validity and utility of a parent-completed, computer-based screening questionnaire is examined in this study.

Method

The participants for this study were 46 mothers who have children aged 15 months to 36 months. Because this research investigated the effectiveness of a screening tool, participants were not excluded from the study on the basis of their child's developmental level. Therefore, both developmentally at-risk children's mothers and normal children's mothers participated in this research. Participants were recruited from four child care centers and three community facilities: a church, a university campus, and a park. Demographic information collected from the 46 mothers at the time of the Computer-Based Developmental Questionnaire completion is presented in Table 1.

Table 1. Demographic Information of the Participants

Demographic Variable	Frequency	(%)
Child Gender		
Male	31	(67.4)
Female	15	(32.6)
Level of Maternal Education		
Less than 12 years	3	(6.5)
12 years	5	(10.9)
13 to 15 years	18	(39.1)
16 or more years	18	(39.1)
Not answered	2	(4.3)
Annual Family Income		
Less than $10,000	14	(30.4)
$10,001 to $20,000	5	(10.9)
$20,001 to $50,000	13	(28.3)
Over $50,000	12	(26.1)
Not answered	2	(4.3)

Participants rated their children with the Computer-Based Developmental Questionnaire (CBQ) and the Child Development Inventory (CDI; Ireton, 1992). The CDI is a standardized instrument used to measure the development of children 15 months to 6 years of age. It has a 270-item inventory that describes eight developmental scales of young children in the areas of social, self-help, gross motor, fine motor, expressive language, language comprehension, letters, and numbers. The CBQ is designed for screening 9-month- to 36-month-old children to identify whether they need further developmental assessment. The questionnaire screened in five areas: adaptive-psychosocial, cognitive, speech-language, fine motor, and gross motor. To determine the items asked in the CBQ, the researcher reviewed child development literature and standardized developmental screening scales (Frankenburg, Fandal, & Thornton, 1987; Ireton & Thwing, 1974; Knobloch, Stevens, & Malone, 1980; Lowrey, 1986; Princeton Center for Infancy and Early Childhood, 1977). From this body of literature, the researcher identified a total of 190 items that could be answered "yes" or "no" by parents. Authorware, an application software, and a Power Macintosh 7100/80 computer were used to transform questions taken from literature into the electronic questionnaire.

The 46 participants were randomly divided into two subgroups by the order of test completion. The mothers completed both the CBQ and the CDI. One subgroup took the CBQ first and the CDI later; the other subgroup took the CDI first and the CBQ later. The groups were divided in this way to control any possible effects of the participants' prior completion of one test on the other test. When completing the CBQ, participants answered questions in five developmental domains. Each response was made by indicating either "yes" or "no." Ceiling points in each of the five areas were set based on the answers given by the respondent. A ceiling point in a domain was a question answered with "yes" followed by two questions answered with "no."

This "yes" question had a point-value associated with it, which determined the raw score for that particular developmental area. Each child thus had raw scores in the five domains as well as one average score that was a general developmental score. The general developmental score and the five domain scores from the CBQ, in turn, were correlated with corresponding scores from the CDI. The data analysis was calculated using computational procedures of SPSS 6.0 (SPSS, Inc., 1993).

Results

Validity of the CBQ

A correlation coefficient is one way to see the degree of relationship between a screening measure and a standardized test to verify concurrent validity. Pearson product moment correlation coefficients were calculated between the two tests. In order to control for the effects of child's age on the various scores of the CBQ and the CDI, partial correlation analysis was used. The partial correlation coefficient provides a measure of linear association between two variables while adjusting for the linear effects of one or more additional variables (Norusis & SPSS, Inc., 1993). Table 2 contains the correlation coefficients between the major CBQ component scores and the CDI scores after the effects of child's age are removed. As can be seen in Table 2, the correlations between the CBQ and the CDI are quite high and significant. The general development score of the CDI that is considered to be most related to learning in school significantly correlates with all the subscales of the CBQ (from $r = .59$ to $r = .85$, $p < .001$). A high correlation was found ($r = .83$) on the general development scores of the two tests. The correlations among five domains of the CBQ and the corresponding components of the CDI are presented in bold in Table 2 (from $r = .61$ to .86, $p < .001$). Those five correlation coefficients show that those are more strongly correlated with corresponding domains than with any other domains. Cognitive domain of the CBQ does not have an exactly corresponding domain in the CDI, however it is strongly correlated with the general development and the social domain of the CDI ($r = .61$ and $r = .68$ respectively). Overall, the correlations between the CBQ and the CDI offer strong support for the concurrent validity of the CBQ. These strong correlations between the two measures suggest that they may be measuring the same constructs.

Table 2. Correlations between the CBQ and the CDI

Test Domains	BAD	BCO	BSL	BFM	BGM	BGD	BDQ
CBQ							
Adaptive (BAD)							
Cognitive (BCO)	.64***						
Speech-Language (BSL)	.78***	.63***					
Fine Motor (BFM)	.56***	.50***	.63***				
Gross Motor (BGM)	.65***	.50***	.59***	.49**			
General Development (BGD)+	.89***	.78***	.93***	.74***	.78***		
Developmental Quotient (BDQ)+	.88***	.78***	.83***	.77***	.79***	.98***	

(table continues)

Table 2. (continued)

Test Domains	BAD	BCO	BSL	BFM	BGM	BGD	BDQ
CDI							
Social	**.84*** **	.68***	.75***	.61***	.65***	.83***	.86***
Self Help	.76***	.58***	.54***	.56***	.64***	.76***	.74***
Gross Motor	.67***	.51***	.62***	.47**	**.78*** **	.74***	.73***
Fine Motor	.57***	.44**	.60***	**.62*** **	.49**	.65***	.66***
Expressive Language	.76***	.50***	**.86*** **	.56***	.42**	.70***	.78***
Language Comprehensive	.74***	.54***	.81***	.54***	.51***	.72***	.78***
General Development +	.85***	**.61*** **	.83***	.59***	.66***	.83***	.87***

Note: Correlation coefficients are Pearson product-moment *rs* controlled for child's age.
Convergent validity coefficients are presented in bold.
+ These components are not independent domain because they are calculated from the other domains.
**p <.01, two-tailed test
***p <.001, two-tailed test

Validity of the CBQ was also examined by comparing the classification of the children by the CBQ and the CDI. Each child was screened for being normal or developmentally at-risk with both the CBQ and the CDI. The percentages of agreement between the two tests were then calculated. No universally accepted definition of developmental delay exists. However, definitions usually require that the child exhibit a 20 to 30% delay in functioning when compared to his or her peers (Bayley, 1993; Eisert, Spector, Shankaran, Faigenbaum, & Szego, 1980; Ireton, 1992). In this study, a child's development on the CBQ and the CDI was classified as developmentally at-risk if the child's scores fell below the 30% below age cutoff on any domain. The 30% below age cutoff of the CDI was reported as equivalent to two standard deviations below the mean (Ireton).

The results of the CBQ classified 34 children as normal and 12 children as at-risk (Table 3). Meanwhile, 31 children were classified as normal and 15 children were classified as at-risk on the CDI when the 30% below cutoff was applied. The sensitivity of a testing instrument is the percentage of developmentally at-risk children correctly identified according to a standardized test. Twelve of the 15 who were identified as at-risk by the CDI were also identified as at-risk by the CBQ, so that the CBQ's classifications were 80% (12/15 x 100) sensitive in the identification of at-risk children. The specificity of a testing instrument is the percentage of children without problems correctly identified. All 31 children who were classified as normal by the CDI were also identified as normal on the CBQ. All classifications of children as normal by the CBQ agreed with classifications of children by the CDI. Therefore, the CBQ was 100% (31/31 x 100) specific in identifying children with normal development. In summary, the classification of children's development as normal or at-risk by the CBQ agreed highly with the classifications of children by the standardized test (CDI) which verifies the validity of the CBQ. Overscreening and underscreening are two potential errors that can occur during any kind of screening. Overscreening refers to the percentage of children labeled as at-risk by the screening test who are found to be normal by the criterion measure. Underscreening refers to the percentage of children not detected by the screening test who are found to be

at-risk on the criterion test (Wolery, 1989). All 12 children who were classified as at-risk on the CBQ were also identified as at-risk on the CDI. No overscreening case was found on the CBQ. However, there were three children who were classified as normal on the CBQ who were found to be at-risk on the CDI. The CBQ's underscreening was 20% (3/15 x 100).

Table 3. Agreement between the two tests

		CDI	
		Normal	At-Risk
CBQ	Normal	31	3
	At-Risk	0	12

Sensitivity:	12/15 x 100 = 80%
Specificity:	31/31 x 100 = 100%
Overscreening	0/31 x 100 = 0%
Underscreening	3/15 x 100 = 20%

Utility of the CBQ

The numbers of questions mothers answered varied from mother to mother because the computer automatically determines a starting point for a series of questions according to the child's chronological age and an ending point to the level of a child's development. The number of questions answered by mothers ranged from 26 to 90 items, with a mean of 47 items (*SD* = 12.70). Time for completion of the CBQ by the mothers was measured by the computer. It included participants' answering the demographic pages, answering the questionnaire, calculating developmental scores, presenting developmental scores on a profile, and saving the data in a file to the computer. Completion time ranged from 5 minutes to 16 minutes with a mean of 8.8 minutes (*SD* = 2.77) and a mode of 7 minutes. The CDI required that parents answer 270 questions. It takes about 30 minutes for the parent to complete the test and 5 minutes to score the results. In contrast, on the CBQ, parents answered about 50 questions and it took about 9 minutes to complete and to score.

Discussion

Correlation Data, Sensitivity, and Specificity of the CBQ

In earlier studies, significant positive correlations were found between parental assessment of children and a professionally administered standardized assessment (Gradel, Thompson, & Sheehan, 1981; Sexton, Hall, & Thomas, 1984). For example, Sonnander (1987) reported results for a parent-completed screening of 18-month-old children in which a high correlation was found (r = .87) between standardized test scores and parental assessment scores. Correlations between the five domains of the

CBQ and the corresponding domains of the CDI ranged from .61 to .87. The high correlations suggest that the CBQ and the CDI are relatively consistent in their ratings of the children's development. Glascoe and Byrne (1993) studied the validity of three developmental screening tests. Those tests were the Denver-II (Frankenburg, Dodds, Archer, Bresnick, Maschka, Edelman, & Shapiro, 1990), the Battelle Developmental Inventory Screening Test (BDI; Newborg, Stock, Wnek, Guidabaldi, & Svinicki, 1984), and the Academic Scale of the Developmental Profile-II (DP-II; Alpern, Boll, & Shearer, 1986). Glascoe and Byrne suggested that a sensitivity of at least 80% was preferred and a specificity of at least 90% was preferred. The sensitivity of Denver-II was adequate (83%), but the specificity of Denver-II was low (46%). In other words, the Denver-II is good at detecting children with difficulties, but it produces a high overreferral rate. This overreferral results in needless parental anxiety and expense, and wastes limited diagnostic resources. DP-II showed adequate specificity (86%), but the sensitivity of the scale was found to be very low (22%). The BDI was more accurate than the other screening tests. The sensitivity and specificity of the BDI were both 72%. Bricker and Squires (1989a, 1989b) examined the validity of a parent-completed screening system called the Infant Monitoring Questionnaires (IMQ). The specificity of the questionnaires was high (over 90%), but the sensitivity was low (63%). This study found that sensitivity of the CBQ was 80% and specificity was 100%. These results suggest that the CBQ is very sensitive to identify developmentally at-risk children correctly and very specific to exclude those children who are normal. However, there is some evidence that the CBQ underscreens children who need further assessments (underscreening = 20%, Table 3).

Completion Time and Cost of the CBQ

Numerous instruments exist which can be more or less useful in screening developmentally at-risk children. However, the majority of the current screening measures are lengthy and have time consuming procedures to interpret the results (Glascoe & Byrne, 1993; Glascoe, Martin, & Humphrey, 1990). Screening measures usually take 20 to 30 minutes to administer and 5 to 10 minutes to score and to interpret. The Denver-II, which is administered by professionals, is reported to take 20 minutes to complete, plus the time involved in scoring the results (Kenny, Hebel, Seston, & Fox, 1987). The BDI screening test takes 10 to 15 minutes to administer for children under 3; for children between 3 and 5, it takes 20 to 30 minutes (Newborg, Stock, Wnek, Guidabaldi, & Svinicki, 1988). The Developmental Profile II usually requires approximately 20 to 40 minutes to administer and score (Alpern, Boll, & Sheater, 1986). The CDI used in this study as a criterion measure usually takes 30 minutes of parents' time to complete and 5 minutes to score. In contrast, the CBQ took about 7 to 10 minutes (mean = 8.8, *SD* = 2.8) by the mothers who did not have a specialized training. The time included completion of demographic screens, completion of questionnaire, scoring, and recording. Because demographic screens were made only for use in this study, without these pages, a reduced time will be expected for a general use of the CBQ. The number of questions answered varied by mothers. It ranged from 26 to 90 items with a mean of 47 items (*SD* = 12.70). These results occurred because mothers were given different numbers of questions according to their children's age and development. This computer system omits unnecessary questions beyond the level of the child's development.

Cost clearly plays a role in the adoption of computer-based assessment. Although development and capital cost may be higher for technology-based assessment, it may yield substantial savings because development costs are one time expenses (Garland, 1995). The cost of implementing CDI for 46 children was about $90 including a manual, questionnaires, answering sheet, and scoring sheet. The cost of implementing the CDI will be multiplied by the numbers of children. This is a case of a parent-administered test so it is relatively inexpensive. However, if a professional needed to administer a screening measure, that system would be more costly. The CBQ eliminated professional time and paperwork, so once it is developed, there is no further cost.

Because of the small sample size, this study could not investigate relationships among child development, parents' ethnic background, and parents' socioeconomic status. In addition, as the CBQ was written in English so the use of the CBQ with groups whose primary language is not English would not be appropriate.

Implications for Future Research

The correlations among the children's various developmental scores on the CBQ and the CDI were significant and strong. The percentages of agreement between the two tests in identifying children as normal or as developmentally at-risk were also high. However, it should be noted that the CBQ is not a diagnostic test. It is only a screening test; therefore, further full scale assessment is needed to confirm the developmental condition of the child. It is important to recognize that a single screening measure of a child with substantial risk factors cannot be used either to confirm or rule out developmental delay (Katz, 1989). A low scoring child is only at-risk, and maybe only temporarily so (Sonnander, 1987). Therefore, the predictive validity, the extent to which the screening test agrees with children's performance on outcome measures later in time, should be investigated. The specificity of the CBQ was 100%, but some underscreening of the CBQ (sensitivity = 80%; underscreening = 20%) was found. Because establishing criterion-related validity is an ongoing process (Allen & Yen, 1979), further studies are necessary to study the validity of the CBQ with other standardized measures.

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